Uranium removal from aqueous solutions by adsorption on Aleppo pine sawdust, modified by NaOH and neutron irradiation

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ABSTRACT

Adsorption of uranium ions from aqueous solutions onto Aleppo pine sawdust was carried out in this study. This adsorbent is untreated, modified with NaOH, and neutron irradiated. The parametric study of uranium(VI) adsorption from aqueous solution onto untreated Aleppo pine sawdust has been investigated using batch equilibrium method at 293 K. The removal efficiency is studied as function of the effect of pH, adsorbent ratio, and contact time. A maximum adsorption capacity was obtained at pH 5 with an adsorbent ratio of 1 g/100 and an equilibrium time of 120 min for all the initial used concentrations. The kinetics of the adsorption process followed a second-order adsorption and the biphasic nature of the plot for intraparticle diffusion, showed diffusion through a film that is followed by a diffusion in the pores. The thermodynamic constants obtained at different temperatures, such as $\Delta G_{\text{ads}}$, $\Delta H_{\text{ads}}$, and $\Delta S_{\text{ads}}$, suggested that the adsorption process is exothermic and spontaneous. In order to compare the adsorption capacities, both NaOH-treated and neutron-irradiated Aleppo pine sawdust were used for uranium(VI) adsorption using the optimal parameters obtained previously. Changes in physicochemical properties of the modified adsorbents were observed with FTIR and scanning electron microscope analyses. Adsorption tests showed that both treated sawdusts gave adsorption capacities better than the untreated sawdust. Four equilibrium models (Langmuir, Freundlich, Dubinin–Radushkevich, and Temkin) were applied to the experimental data in order to determine the better model for the systems. Langmuir isotherm seems the most appropriate for the adsorption of uranium(VI) with maximum adsorption capacities of 19.56, 48.66, 35.15, and 30.98 mg/g for the untreated, treated with NaOH, and neutron-irradiated (1 H and 4 H) sawdust, respectively.

Keywords: Sawdust; Wastes; Neutron irradiation; Adsorbent modified; Adsorption; Isotherm; Kinetic; Thermodynamic; Uranium